

Listing of claims:

A listing of the unamended claims, provided for the Examiner's reference, are as follows:

1. - 12. (Canceled)

13. (Previously Presented) A regeneration controller for eliminating particulate matter accumulated in an exhaust purification apparatus that is arranged in an exhaust system of an internal combustion engine, the regeneration controller comprising:

a heating section for heating the exhaust purification apparatus to eliminate the particulate matter accumulated in the exhaust purification apparatus when an estimated accumulation amount is greater than a reference accumulation amount, wherein the heating section obtains the estimated accumulation amount by estimating the amount of particulate matter accumulated in the exhaust purification apparatus; and

a mode change section for changing exhaust purification apparatus heating modes when heating the purification apparatus if the estimated accumulation amount is within a mode change range, wherein:

an exhaust having an air-fuel ratio flows the exhaust system;

the mode change range is set in accordance with a state in which a great part of the accumulated particulate matter is eliminated from the exhaust purification apparatus; and

the mode change section changes the heating mode when the estimated accumulation amount is within the mode change range and less than or equal to a normal burn-up start determination value, which is slightly greater than an end determination value, from a normal heating mode, for heating the exhaust purification apparatus by continuously keeping the air-fuel ratio in the exhaust system low, to a burn-up heating mode, for burning up the particulate matter by intermittently lowering the air-fuel ratio in the exhaust system so that a temperature of a catalyst bed is elevated so that the temperature of the catalyst bed is higher in the burn-up heating mode than in the normal heating mode.

14. (Previously Presented) The regeneration controller according to claim 13, further comprising:

a difference detection unit for detecting exhaust pressure difference between an upstream side and a downstream side of the exhaust purification apparatus;

wherein the mode change section determines whether to change the heating mode to the burn-up heating mode based on the exhaust pressure difference detected by the pressure detection unit.

15. (Previously Presented) The regeneration controller according to claim 13, further comprising:

a difference detection unit for detecting at least one of an exhaust pressure difference and an exhaust temperature difference between an upstream side and a downstream side of the exhaust purification apparatus, in which the exhaust purification apparatus is a downstream side one of at least two exhaust purification apparatuses arranged in the exhaust system;

wherein the mode change section determines whether to change the heating mode to the burn-up heating mode based on at least one of the exhaust pressure difference and the exhaust temperature difference detected by the pressure detection unit.

16. (Previously Presented) The regeneration controller according to claim 13, wherein the exhaust purification apparatus includes a downstream portion, the regeneration controller further comprising:

a difference detection unit for detecting exhaust temperature difference between an upstream side and a downstream side of the downstream portion the exhaust purification apparatus;

wherein the mode change section determines whether to change the heating mode to the burn-up heating mode based on the exhaust temperature difference detected by the pressure detection unit.

17. (Previously Presented) The regeneration controller according to claim 14, wherein the mode change section increases the estimated accumulation amount and continues the burn-up heating mode when the exhaust pressure difference or the exhaust temperature

difference detected by the difference detection unit is greater than a mode change reference value.

18. (Previously Presented) The regeneration controller according to claim 14, wherein the mode change section limits the execution of the burn-up heating to a predetermined number of times when the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is less than a mode change reference value.

19. (Previously Presented) The regeneration controller according to claim 14, wherein the mode change range includes a first mode change range and a second mode change range, which is narrower than the first mode change range, and wherein the mode change section:

increases the estimated accumulation amount and continues burn-up heating when the estimated accumulation amount is within the first mode change region and the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is greater than the mode change reference value; and

executes the burn-up heating in a manner limited to a predetermined number of times when the estimated accumulation amount is within the second mode change region and the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is less than a mode change reference value.

20. (Previously Presented) The regeneration controller according to claim 17, wherein the mode change section limits the number of times for increasing the estimated accumulation amount to a reference number of times or less.

21. (Previously Presented) The regeneration controller according to claim 18, wherein the mode change section:

temporarily suspends execution of the burn-up heating when executing the burn-up heating in a manner limited to the predetermined number of times; and

determines that the execution of the burn-up heating has been executed the predetermined number of times regardless of an actual number of times the burn-up heating has been performed after a predetermined period elapses from when the execution of the burn-up heating is suspended and the estimated accumulation amount becomes zero.

22. (Previously Presented) The regeneration controller according to claim 19, wherein the mode change reference value represents the exhaust pressure difference or the exhaust temperature difference that is predicted when the estimated accumulation amount is in the first mode change range.

23. (Previously Presented) A method for eliminating particulate matter accumulated in an exhaust purification apparatus arranged in an exhaust system of an internal combustion engine, the method comprising:

- estimating the amount of particulate matter accumulated in the exhaust purification apparatus to obtain an estimated accumulation amount;

- determining whether the estimated accumulation amount is greater than a reference accumulation amount;

- starting a normal heating mode for continuously keeping the air-fuel ratio in the exhaust system low by continuously adding fuel to exhaust when the estimated accumulation amount is greater than the reference accumulation amount;

- determining whether the estimated accumulation amount is less than or equal to a normal burn-up start determination value, which is slightly greater than an end determination value and less than the reference accumulation amount; and

- changing from the normal heating mode to a burn-up heating mode for intermittently lowering the air-fuel ratio in the exhaust system by intermittently adding fuel to the exhaust when the estimated accumulation amount within a mode change range set in accordance with a state in which a great part of the accumulated particulate matter is eliminated from the exhaust purification apparatus and is less than or equal to the normal burn-up start determination value so that a temperature of a catalyst bed is elevated so that the temperature of the catalyst bed is higher in the burn-up heating mode than in the normal heating mode.

24. (Previously Presented) The regeneration controller according to claim 15, wherein the mode change section increases the estimated accumulation amount and continues the burn-up heating mode when the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is greater than a mode change reference value.

25. (Previously Presented) The regeneration controller according to claim 15, wherein the mode change section limits the execution of the burn-up heating to a predetermined number of times when the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is less than a mode change reference value.

26. (Previously Presented) The regeneration controller according to claim 15, wherein the mode change range includes a first mode change range and a second mode change range, which is narrower than the first mode change range, and wherein the mode change section:

increases the estimated accumulation amount and continues burn-up heating when the estimated accumulation amount is within the first mode change region and the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is greater than the mode change reference value; and

executes the burn-up heating in a manner limited to a predetermined number of times when the estimated accumulation amount is within the second mode change region and the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is less than a mode change reference value.

27. (Previously Presented) The regeneration controller according to claim 16, wherein the mode change section increases the estimated accumulation amount and continues the burn-up heating mode when the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is greater than a mode change reference value.

28. (Previously Presented) The regeneration controller according to claim 16, wherein the mode change section limits the execution of the burn-up heating to a predetermined number of times when the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is less than a mode change reference value.

29. (Previously Presented) The regeneration controller according to claim 16, wherein the mode change range includes a first mode change range and a second mode change range, which is narrower than the first mode change range, and wherein the mode change section:

increases the estimated accumulation amount and continues burn-up heating when the estimated accumulation amount is within the first mode change region and the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is greater than the mode change reference value; and

executes the burn-up heating in a manner limited to a predetermined number of times when the estimated accumulation amount is within the second mode change region and the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is less than a mode change reference value.

30. (Previously Presented) The regeneration controller according to claim 19, wherein the mode change section limits the number of times for increasing the estimated accumulation amount to a reference number of times or less.

31. (Previously Presented) The regeneration controller according to claim 19, wherein the mode change section:

temporarily suspends execution of the burn-up heating when executing the burn-up heating in a manner limited to the predetermined number of times; and

determines that the execution of the burn-up heating has been executed the predetermined number of times regardless of an actual number of times the burn-up heating has been performed

after a predetermined period elapses from when the execution of the burn-up heating is suspended and the estimated accumulation amount becomes zero.

32. (Previously Presented) The regeneration controller according to claim 13, wherein the mode change section determines if the estimated accumulation amount is within the mode change range and changes the heating mode when the estimated accumulation amount is within the mode change range from the normal heating mode to the burn-up heating mode

33. (Previously Presented) A regeneration controller for eliminating particulate matter accumulated in an exhaust purification apparatus that is arranged in an exhaust system of an internal combustion engine, the regeneration controller comprising:

a heating section for heating the exhaust purification apparatus to eliminate the particulate matter accumulated in the exhaust purification apparatus when an estimated accumulation amount is greater than a reference accumulation amount, wherein the heating section obtains the estimated accumulation amount by estimating the amount of particulate matter accumulated in the exhaust purification apparatus; and

a mode change section for changing exhaust purification apparatus heating modes when heating the purification apparatus if the estimated accumulation amount is within a mode change range, wherein:

an exhaust having an air-fuel ratio flows the exhaust system;

the mode change range is set in accordance with a state in which a great part of the accumulated particulate matter is eliminated from the exhaust purification apparatus; and

the mode change section changes the heating mode when the estimated accumulation amount is within the mode change range from a normal heating mode, for heating the exhaust purification apparatus by continuously keeping the air-fuel ratio in the exhaust system low, to a burn-up heating mode, for burning up the particulate matter by intermittently lowering the air-fuel ratio in the exhaust system so that a temperature of a catalyst bed is elevated so that the temperature of the catalyst bed is higher in the burn-up heating mode than in the normal heating mode;

in the burn-up heating mode, the amount of fuel repeatedly added, the period of fuel addition, and the period when fuel is not added are set so as to realize activated oxygen state and exhaust temperatures at upstream and downstream sides of the exhaust purification apparatus capable of burning up the particulate matter accumulated in the exhaust purification apparatus.

34. (Previously Presented) A method for eliminating particulate matter accumulated in an exhaust purification apparatus arranged in an exhaust system of an internal combustion engine, the method comprising:

- estimating the amount of particulate matter accumulated in the exhaust purification apparatus to obtain an estimated accumulation amount;

- determining whether the estimated accumulation amount is greater than a reference accumulation amount;

- starting a normal heating mode for continuously keeping the air-fuel ratio in the exhaust system low by continuously adding fuel to exhaust when the estimated accumulation amount is greater than the reference accumulation amount;

- determining whether the estimated accumulation amount is less than or equal to a determination value, which is less than the reference accumulation amount; and

- starting a burn-up heating mode for intermittently lowering the air-fuel ratio in the exhaust system by intermittently adding fuel to the exhaust when the estimated accumulation amount is within a mode change range set in accordance with a state in which a great part of the accumulated particulate matter is eliminated from the exhaust purification apparatus and less than or equal to the determination value so that a temperature of a catalyst bed is elevated so that the temperature of the catalyst bed is higher in the burn-up heating mode than in the normal heating mode, wherein in the burn-up heating mode, the amount of fuel repeatedly added, the period of fuel addition, and the period when fuel is not added are set so as to realize activated oxygen state and exhaust temperatures at upstream and downstream sides of the exhaust purification apparatus capable of burning up the particulate matter accumulated in the exhaust purification apparatus.